DISCIPLINE OF MECHANICAL ENGINEERING

STUDY GUIDE

UNIVERSITY OF
KWAZULU-NATAL

Adapted, with permission, from the University of Pretoria *Departmental Study Guide* for Mechanical and Aeronautical Engineering (2008) compiled by K.J. Craig, A.G. Malan, S. Kok, and J.P. Meyer

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1. GENERAL SCHOOL ADMINISTRATION AND REGULATIONS

1.1 Integrity and professionalism

- Mechanical Engineering is a public space occupied by staff offices, laboratories and lecture theatres. When entering the building, students are required to keep their noise and conversation levels down.
- The playing of music in the Mechanical Engineering building is prohibited, whether on cell phones, iPods or any other device.
- Students may not consume food or beverages in any lecture theatre, study room or computer LAN.
- Students are encouraged to ask the lecturer questions in class, however they are required to remain quiet at all other times during lectures.
- Students must treat each other and staff members with respect in their interactions.
- Students are to address staff by their titles and surnames in all verbal and written communication, and not by their first names.
- Students may not bring any weapon or dangerous item onto campus.
- Students must conform to all workshop and laboratory safety regulations.
- Students may not enter the Mechanical Engineering building without shoes. Closed shoes are to be worn in the workshop at all times.
- Cheating will not be tolerated. Students found guilty of cheating, dishonesty or plagiarism will be subject to the full disciplinary processes of the University. If found guilty of any form of cheating, a student's parents and bursary sponsors may be notified of the offense.
- Students may not use offensive language within the Mechanical Engineering building. This includes profanity (swearing), pejorative language and obscenity, whether in conversation with each other or in the presence of staff members.
- Crude or disrespectful behaviour is not allowed.
- No student may enter the Mechanical Engineering building without a valid student card, and no student may assist any other person to enter the building by opening security doors or subverting the access-control systems that are in place.
- All students are expected to behave politely and with courtesy. The following serve as examples of courtesy, not just in academia but in the workplace generally:
    - Using 'please' and 'thank you' where appropriate.
    - Arriving on time to lectures, practicals and meetings.
    - Switching off cell phones in lectures and during meetings with staff.
    - Knocking before entering an office, and waiting to be invited in.
    - Disposing of litter in bins.

  The following serve as examples of discourtesy or impoliteness:
- Talking while a lecture is in progress.
- Playing music or games in the LANs.
- Parking in such a way as to obstruct other vehicles.
- Leaving laboratories or workshop areas in a mess after use.
- Students must follow the official email protocol when communicating with staff members. See http://mecheng.ukzn.ac.za/StudentResources.aspx.
- Students are forbidden from consuming alcohol or drugs on campus.
- Students are not permitted to engage in loud conversation or disruptive behaviour in the computer LANs.
- Access to the study rooms and LANs is permitted for legitimate study purposes only. Gaming is prohibited, as is the downloading of illegal software, music or offensive material.
- Students may not bring a person into a lecture who, is not registered for the subject.
- Students may not smoke near the entrance of the Mechanical Engineering building, nor may they litter or discard cigarette butts on the ground.
- The above rules apply in addition to the University's Rules for Student Discipline.

1.2 **Course-related information**

The URL for the School of Mechanical Engineering website is
http://mecheng.ukzn.ac.za/Homepage507.aspx

1.3 **Formal communication**

- You may communicate with your lecturers via email provided you use the subject line to describe what the email is about, and make it clear who the sender of the email is.

- If you experience difficulty understanding something in a lecture, your best course of action is to approach a class rep. If he/she cannot help you, you can approach the lecturer.

- If you experience personal problems of an academic nature that cannot be resolved by a lecturer, you may approach the Head of School.

1.4 **Workshop and safety measures**

All students and staff members are bound by the Occupational Health and Safety Act whilst using machines and other equipment in the laboratories and workshops. Please read the following regulations carefully: Occupational Health and Safety Act, 1993, on
http://www.acts.co.za/ohs/index.htm Mine Health and Safety Act, 1996,
http://www.acts.co.za/mhs/index.htm

1.5 **Plagiarism**

It is critical that you understand what plagiarism is and avoid committing it when you write assignments and reports.

You commit plagiarism when you use another person's words, ideas, or opinions without acknowledgement. If you copy someone else's work word-for-word (verbatim), or submit the work in a slightly altered form (such as changing a word to another one with the same meaning), you are committing plagiarism.

You need to provide references for quotes (the exact words of another person), paraphrases (someone else's ideas and opinions given in your own words), and summaries (main points of someone else's opinions, theories, or data).
It does not matter how much of someone else's work you use (a sentence or a whole paragraph), or whether you do it intentionally or unintentionally. If you submit the work as your own, you are committing intellectual theft which is regarded as a serious contravention of academic rules and could lead to your expulsion from the university.

Even if another student gives you permission to use one of his or her past papers to hand in as your own, you are committing plagiarism. You are not allowed to pass off another student's work as your own.

While academic staff will educate you about the appropriate systems of referencing, you need to take responsibility for your own academic career. Speak to your lecturer if you are uncertain about how to avoid committing plagiarism.

You can also consult the following website:
Plagiarism: What is it and How to Recognise and Avoid it
http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml

1.6 **Class Representative Duties**

The class representative is responsible for:

- Liaising with lecturers and mentors on behalf of students.
- Providing student leadership.

1.7 **Vacation work**

To satisfy the degree in Engineering, you have to complete 14 weeks of industrial training. This work must be performed under the supervision of an engineer and will vary depending on the type of industry, facilities available, and type of programme.

While every effort is made to place students with firms for vacation work, employment opportunities cannot be guaranteed. You are encouraged to arrange your own work and to accept offers made by bursars.

You are required to write a report and submit a certificate of progress from the firm concerned within six weeks of the start of semester. The format of the report is stipulated in the hand-out: Guide for Writing Vacation Work reports.

1.8 **University Regulations**

Please acquaint yourself with the University's faculty and examination regulations in the year book.

You are required to take responsibility for your own studies. This means arriving at lectures on time and attending regularly; monitoring your own progress; and seeking assistance if you are performing under par. You also need to complete and hand in all assignments on time. Pay attention to the DP requirements in each of your modules, and make sure that you fulfil them.

2. **ENGINEERING COUNCIL OF SOUTH AFRICA (ECSA) GENERAL OUTCOMES**

2.1 **Exit-Level Outcomes for Engineering Bachelor Degrees**

(Excerpt from ECSA Document No PE-61: Standards for Accredited University Bachelor degrees)

Exit-Level Outcomes: Exit-level outcomes are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulated practice environment.

Range Statement
The competencies defined in the ten exit-level outcomes may be demonstrated in a university-based, simulated workplace environment. Competencies, generically stated, may be assessed in various engineering disciplinary or cross-disciplinary contexts.

ELO 1 **PROBLEM SOLVING**	**ELO 6** **PROFESSIONAL AND TECHNICAL COMMUNICATION**
ELO 2 **APPLICATION OF SCIENTIFIC AND ENGINEERING KNOWLEDGE**	**ELO 7** **IMPACT OF ENGINEERING ACTIVITY**
ELO 3 **ENGINEERING DESIGN**	**ELO 8** **INDIVIDUAL, TEAM AND MULTIDISCIPLINARY WORK**
ELO 4 **INVESTIGATIONS, EXPERIMENTS, AND DATA ANALYSIS**	**ELO 9** **INDEPENDENT LEARNING ABILITY**
ELO 5 **ENGINEERING METHODS, SKILLS, AND TOOLS, INCLUDING INFORMATION TECHNOLOGY**	**ELO 10** **ENGINEERING PROFESSIONALISM**

Exit Level Outcome 1: Problem Solving

Learning Outcome: Demonstrate competency to identify, assess, formulate, and solve convergent and divergent engineering problems innovatively and creatively.

Associated Assessment Criteria
This candidate applies, in a number of varied instances, a systematic problem solving method, including:

1. Analysing and defining the problem, and identifying the criteria for an acceptable solution.
2. Identifying necessary information and applicable engineering and other knowledge and skills.
3. Generating and formulating possible approaches to solving the problem.
4. Modelling and analyzing possible solution(s).
5. Evaluating possible solutions and selecting the best one.
6. Formulating and presenting the solution in an appropriate form.

Range Statement
Problems require identification and analysis. Some cases occur in unfamiliar contexts. Problems are both concrete and abstract and may involve uncertainty. Solutions are based on theory and evidence, together with judgment where necessary.

Exit Level Outcome 2: Application of Scientific and Engineering Knowledge

Learning Outcome: Demonstrate competence to apply knowledge of mathematics, basic science, and engineering sciences from first principles, to solve engineering problems.

Associated Assessment Criteria
The candidate:

1. Applies mathematical and numerical analysis, and statistical knowledge and methods to solving engineering problems by using an appropriate mix of:
   a) Formal analysis and modeling of engineering components, systems, and processes.
   b) Communicating concepts, ideas, and theories with the aid of mathematics.
   c) Reasoning about and conceptualizing engineering components, systems, or processes using mathematical concepts.

2. Uses physical laws and knowledge of the physical world as a foundation for the engineering sciences and the solution of engineering problems by using an appropriate mix of:
   a) Formal analysis and modeling of engineering components, systems, or processes using principles and knowledge of the basic sciences.
   b) Reasoning about and conceptualizing engineering problems, components, systems, or processes using principles of the basic sciences.

3. Uses the techniques, principles, and laws of engineering science at a fundamental level and in at least one specialist area to:
   a) Identify and solve open-ended engineering problems.
   b) Identify and pursue engineering applications.
   c) Work across engineering disciplinary boundaries by applying cross-disciplinary literacy and shared fundamental knowledge.

Range Statement
Knowledge is coherent and systematically organized, covering the fundamentals of the discipline, showing depth in limited specialist area(s), informed by current developments. A coherent and critical understanding of fundamental principles and theories of the *discipline* is required. Understanding of emerging issues in specialist area(s). Application of knowledge also requires recognition of boundaries and limitations of disciplines.

Exit Level Outcome 3: Engineering Design

Learning Outcome: Demonstrate competence to perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products and processes.

Associated Assessment Criteria
The candidate executes an acceptable design process encompassing the following:
1. Identifying and formulating the design problem to satisfy user needs, applicable standards, codes of practice, and legislation.
2. Planning and managing the design process: focusing on important issues, recognizing and dealing with constraints.
3. Acquiring and evaluating the requisite knowledge, information and resources: applying correct principles, evaluating and using design tools.
4. Performing design tasks including analysis, quantitative modeling, and optimization.
5. Evaluating alternatives and preferred solution: exercising judgment, tests implementability, and performing techno-economic analyses.
6. Assessing impacts and benefits of the design: social, legal, health, safety and environmental.

Range Statement
A major design problem should be used to provide evidence. The problem would be typical of that in which the graduate would participate in a typical employment situation shortly after graduation. The selection of components, systems, engineering works, products, or processes to be designed is dependent on the discipline.

Exit Level Outcome 4: Investigations, Experiments, and Data Analysis

Learning Outcome: Demonstrate competence to design and conduct investigations and experiments.

Associated Assessment Criteria
The candidate executes an acceptable process including but not restricted to :
1. Planning and conducting investigations and experiments.
2. Conducting a literature search and critically assessing the material.
3. Performing necessary analyses.
4. Selecting and using appropriate equipment and software.
5. Analysing, interpreting and deriving information from data.
6. Drawing conclusions based on evidence.
7. Communicating the purpose, process, and outcomes in a technical report.

Range Statement
The balance of investigation and experiment should be appropriate to the discipline. An investigation or experimental study should be typical of those in which the graduate would participate in an employment situation shortly after graduation.
Note: an investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon, and to recommend a course of action.

Exit Level Outcome 5: Engineering Methods, Skills, and Tools including Information Technology

Learning Outcome: demonstrate competence to use appropriate engineering methods, skills and tools, including those based on information technology.

Associated Assessment Criteria
The candidate:
1. Uses methods, skills, and tools effectively by:
    a) Selecting and assessing the applicability and limitations of the method, skill or tool.
    b) Properly applying the method, skill or tool.
    c) Critically testing and assessing he end-results produced by the method, skill or tool.
2. Creates computer applications as required by the discipline.

Range Statement
A range of methods, skill, and tools appropriate to the disciplinary designation of the programme, including:
1. Discipline-specific tools, processes or procedures.
2. Computer packages for computation, modeling, simulation and information handling.
3. Computer and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork.
4. Basic-techniques form economics, business management, and health, safety, and environmental protection.

Exit Level Outcome 6: Professional and Technical Communication

Learning Outcome: demonstrate competence to communicate effectively, both orally and in writing with engineering audiences at large.

Associated Assessment Criteria

1. The candidate executes effective written communication as evidenced by:
   a) Using appropriate structure, style and language for purpose and audience.
   b) Using effective graphical support.
   c) Applying methods of providing information for use by others involved in engineering.
   d) Meeting the requirements of the target audience.

2. The candidate executes effective oral communication as evidenced by:
   a) Using appropriate structure, style and language.
   b) Using appropriate visual materials.
   c) Delivering presentations fluently.
   d) Meeting requirements of the intended audience.

Range Statement

Material to be communicated is in an academic or simulated professional context. Audiences range from engineering peers to management and lay persons, requiring appropriate academic or professional discourse. Written reports range from short (300-1,000 words plus tables and diagrams) to long documents (10,000 to 15,000 words plus tables, diagrams, and appendices, covering material at exit level. Methods of providing information include the conventional methods of discipline, for example engineering drawings, as well as subject-specific methods.

Exit Level Outcome 7: Impact of Engineering Activity

Learning Outcome: demonstrate critical awareness of the impact of engineering activity on the social, industrial, and physical environment.

Associated Assessment Criteria

The candidate indentifies and deals with an appropriate combination of issue in:

1. The impact of technology on society.
2. Occupational and public health and safety.
3. Impacts on the physical environment.
4. The personal, social, and cultural values and requirements of those affected by engineering activity.

Range Statement

The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the discipline or other = designation of the qualification.

Exit-Level Outcome 8: Individual, Team, and Multidisciplinary Work

Learning Outcome: Demonstrate competence to work effectively as an individual, in team, and in multidisciplinary environments.

Associated Assessment Criteria

1. The candidate demonstrates effective individual work by performing the following:
   a) Identifying and focusing on objectives.
   b) Working strategically.
   c) Executing tasks effectively.
   d) Delivering completed work on time.

2. The candidate demonstrates effective team work by the following:
   a) Making individual contribution to team activity.
   b) Performing critical functions.
   c) Enhancing work of fellow team members.
   d) Benefitting from support of team members.
   e) Communicating effectively with team members.
   f) Delivering completed work on time.

3. The candidate demonstrates multidisciplinary work by the following:
   a) Acquiring a working knowledge of co-workers' discipline.
   b) Using a systems approach.
   c) Communicating across disciplinary boundaries.

Range Statement
Tasks require cooperation across at least one disciplinary boundary. Disciplines may be other engineering disciplines or be outside engineering.

Exit-Level Outcome 9: Independent Learning Ability
Learning Outcome: demonstrates competence to engage in independent learning through well developed learning skills.

Associated Assessment Criteria
The candidate shows evidence of being an effective independent learner by the following:
1. Reflecting on own learning and determining learning requirements and strategies.
2. Sourcing and evaluating information.
3. Accessing, comprehending, and applying knowledge acquired outside formal instruction.
4. Critically challenging assumptions and embracing new thinking.

Range Statement
Operate independently in complex, ill-defined contexts requiring personal responsibility and initiative. Accurately self-evaluate and take responsibility for learning requirements. Be aware of social and ethical implications of applying knowledge in particular contexts.

Exit-Level Outcome 10: Engineering Professionalism
Learning Outcome: demonstrates critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence.

Associated Assessment Criteria
The candidate exhibits professionalism by the following:
1. Being aware of the requirements to maintain continued competence and keeping abreast of up-to-date tools and techniques.
2. Displaying understanding of the system of professional development.
3. Accepting responsibility for own actions.
4. Displaying judgment in decision making during problem solving and design.
5. Limiting decision making to area of current competence.
6. Reasoning about and making judgments on ethical aspects in case study context.
7. Discerning boundaries of competence in problem solving and design.

Range Statement
Evidence includes case studies typical of engineering practice situations in which the graduate is likely to practice.

2.2 Knowledge Areas

The Bachelor's programme contains a coherent core of mathematics, basic sciences, and fundamental engineering sciences, and fundamental engineering sciences that provides a stepping stone for further studies and lifelong learning. The coherent content enables development in a traditional discipline or emerging field, and embraces fundamental as well as core elements as defined by SAQA. Below is a list of knowledge areas and required SAQA credits.

Knowledge Area	Minimum Required SAQA Credits
1. Mathematical Sciences	56
2. Basic Sciences	56
3. Engineering Sciences	168
4. Design and Synthesis	67
5. Computing and IT	17
6. Engineering Professionalism/Complementary Studies	56
Subtotal	420
Discretionary	>140
Total Credits	≥560

3. USEFUL LINKS

Online Magazines

- Mechanical Engineering Magazine - http://memagazine.asme.org/
- Machine Design - http://machinedesign.com/
- Popular Mechanics - http://www.popularmechanics.com/
- Car Magazine - http://www.cartoday.com/
- TopCar - http://mags.wheel24.co.za/TopCar/Home/

Societies and Organizations

- Engineering Council of South Africa - http://www.ecsa.co.za/
- South African Institute of Mechanical Engineers - http://http//www.saimeche.org.za/
- SAIMechE - http://www/saimeche.org.za/
- American Society of Mechanical Engineers – http://www.asme.org/
- American Society of Testing and Materials - http://www/astm.org/
- IMechI - http://www.imeche.org/
- International Organization for Standardization Online – http://www.iso.ch/iso/home.htm
- South African Buro of Standards - http://http//www.sabs.co.za/
- American National Standards Institute Online - http://www.ansi.org/
- German Institute for Standardization - http://http//www.en.din.de/
- British Standards Institute - http://http//www.bsi-global.com/index.html

Engineering Info

- EZEE-DEX - Products Search Engine - http://www.edx.co.za/index.htm
- MatWeb - Online Materials Info - http://www.matweb.com/
- Digital Library for Engineering Education - http://www.needs.org/needs/
- Interactive Guide to Strain Measurement Technology – http://www.vishay.com/strain-gages/
- FEA Info by Dermot Monaghan – http://www.dermotmonaghan.com/

Patent Searches

- United States Patent and Trademark Office – http://www.uspto.gov/
- USPTO Web Patent Databases - http://patents.cnidr.org/
- Patent Law Web Server - http://www.patents.com/

How things work and other interesting stuff

- Automotive Learning Online - http://www.innnerauto.com/
- How Stuff Works - http://adventure.howstuffworks.com/
- Engineering Fundamentals (EFunda) – http://www.efunda.com/home.cfm
- Wacky Patent of the Month - http://colitz.com/site/wacky.htm

4. ASAP
ACADEMIC SUPPORT - ADVANCEMENT PROGRAMME

The Academic Support Advancement Programme (ASAP) is a faculty wide initiative. The programme is putting into place strategies to assist students in their studies, whether it be with assistance in specific modules (through tutoring and supplemental instruction), general learning strategies (through our weekly workshops and advice from the Academic Development Officers), assistance with academic writing for reports and assignments and staff development. The implementation of the programme will take into consideration existing interventions, such as the Mentorship Programme as well as discipline based tutorial systems.

WHAT WE OFFER:

- Supplemental Instruction. Additional sessions with trained peers to assist with understanding of modules which students have found difficult in the past. Look out on the notice boards and in your lectures for details of modules in your school where this is offered.
- Weekly workshops. Learn more about time management, study skills, note taking and exam preparation. Workshops will be run weekly during the semester in the Thursday forum period.
- Writing Assistance. Additional support for all your reports and assignments, we will be offering one to one advice on report writing and academic literacy in the Schools, your ADO has more details.
- One on one advice. All the Academic Development Officers are based within the Faculty and can assist you on an individual basis.
- A drop in centre and LAN facility (watch out for workshops on programming and general computer use during the semester)

For further details, see the ADO in your school, check the school notice boards and watch your e-mail.

What is Supplemental Instruction (SI)?
Supplemental Instruction is not a tutoring programme, but a tried and tested facilitation approach (originated at the University of Missouri at Kansas City in 1973) which facilitates learning and understanding. Statistics to date (it is taught in over 800 institutions in 27 different countries and has become a sought-after qualification) attest to its effectiveness.

SI is a peer facilitated academic support program that targets difficult courses (rather than problem students) to improve student performance and retention through regular out-of-class review sessions.

Main features of the Programme

1. SI leaders are trained and paid.
2. SI is not viewed as remedial.
3. The sessions focus on collaborative learning and therefore differ from traditional tutorials in which re-lecturing takes place; the class experience is enhanced, not duplicated.
4. Learners are active and take responsibility for their own learning.
5. SI leaders attend lectures and regularly meet with lecturers.
6. The SI programme is constantly evaluated (SI supervisors observe classes and student performance is monitored) to ensure that a high standard is maintained.
7. It is a cost-effective vehicle for transformation.
8. SI is a collaborative partnership between lecturers. SI supervisor, and SI leaders.
9. Attendance is voluntary.

Who are the SI leaders?

SI Leaders are undergraduate students who have previously taken the course and demonstrated academic competency in the subject area. Final selections are made on the basis of interviews aimed at assessing interpersonal skills and commitment to the programme.

SI Goals

SI aims to instill in learners critical thinking, effective communication, learning skills, self-esteem and confidence, a sense of accomplishment, and the ability to work with others. And most importantly, SI aims to reduce attrition and achieve a high throughput rate.

Typical activities in an SI session

Incomplete outlines, group problem solving, informal quizzes, probing questions, note cards, mnemonic devices, mock exams, vocabulary activities.

Supervisor roles

Supervisors provide ongoing training, administrative support, and expertise in facilitation skills to SI leaders, and conduct evaluations.